Post-retrocommissioning HVAC Operations Monitoring using Enterprise-wide Energy Management System

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Overview

- Process of HVAC retro-commissioning
- eQUEST energy model to create baselines and estimate savings
- Tactical use of EEMIS for optimized HVAC operations
- 3-Prong approach for sustainable savings
  - Equipment monitoring using data from EEM Suite
  - Utility bill analysis by means of Utility Accountant
  - System-level benchmarks using UCE+ module to help detect deviations from the optimized state

What is Cx / RCx?

- Cx: New building commissioning provides documented confirmation that building systems function according to design
- RCx: Retrocommissioning existing buildings is a systematic process for improving building HVAC operation and maintenance

Retrocommissioning (RCx) Project Funding

- CPUC 04/05:
  - 11 Facilities (1.6 million GSF)
- LACo-CEO 06/07:
  - 3 Facilities (1.5 million GSF)
- CPUC 06/08:
  - 18 Facilities (3.6 million GSF) ongoing
- Facilities maintained and operated by the County

Adopted RCx Process

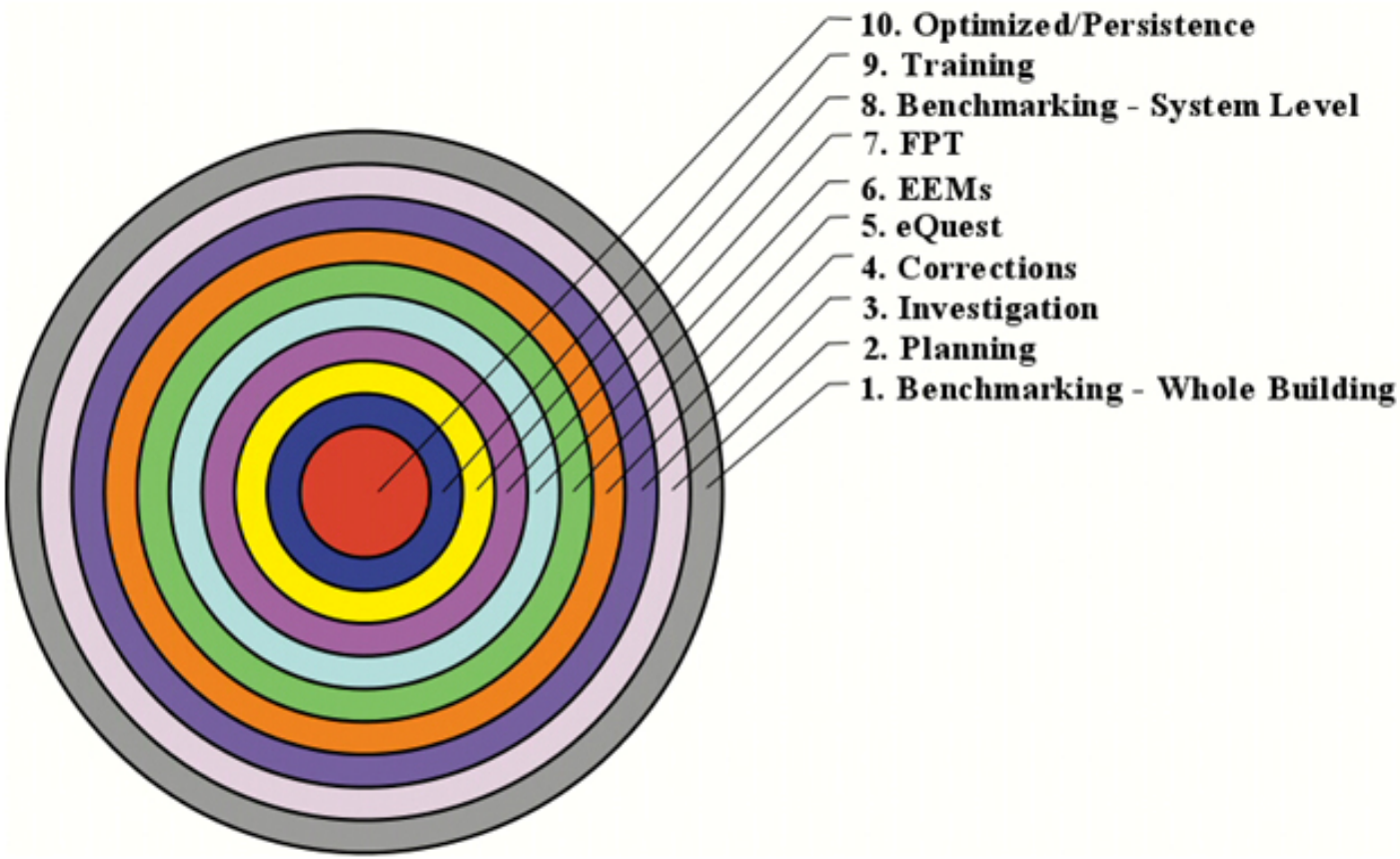
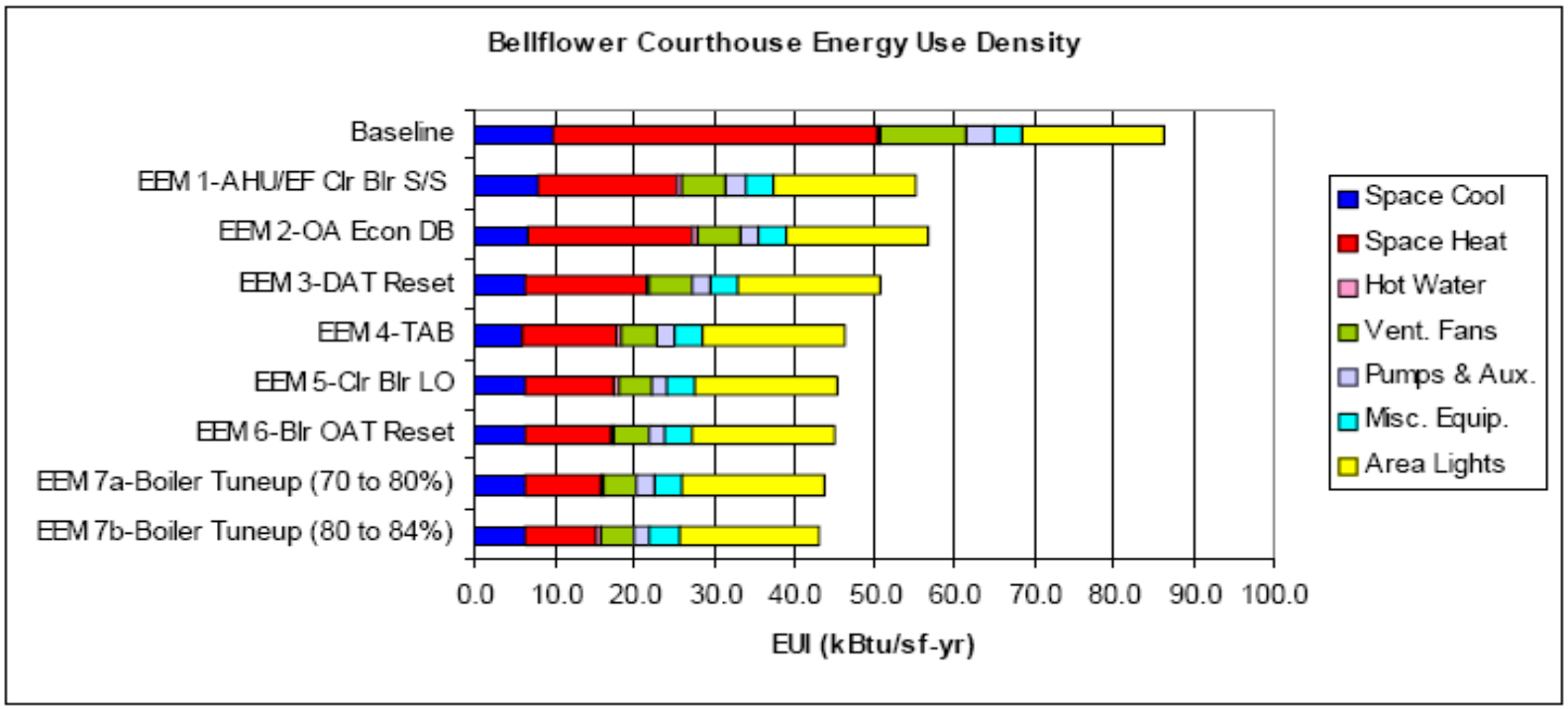


Figure 1. Retro-commissioning (RCx) process adapted by SCE/SCG/County of LA Partnership Program.

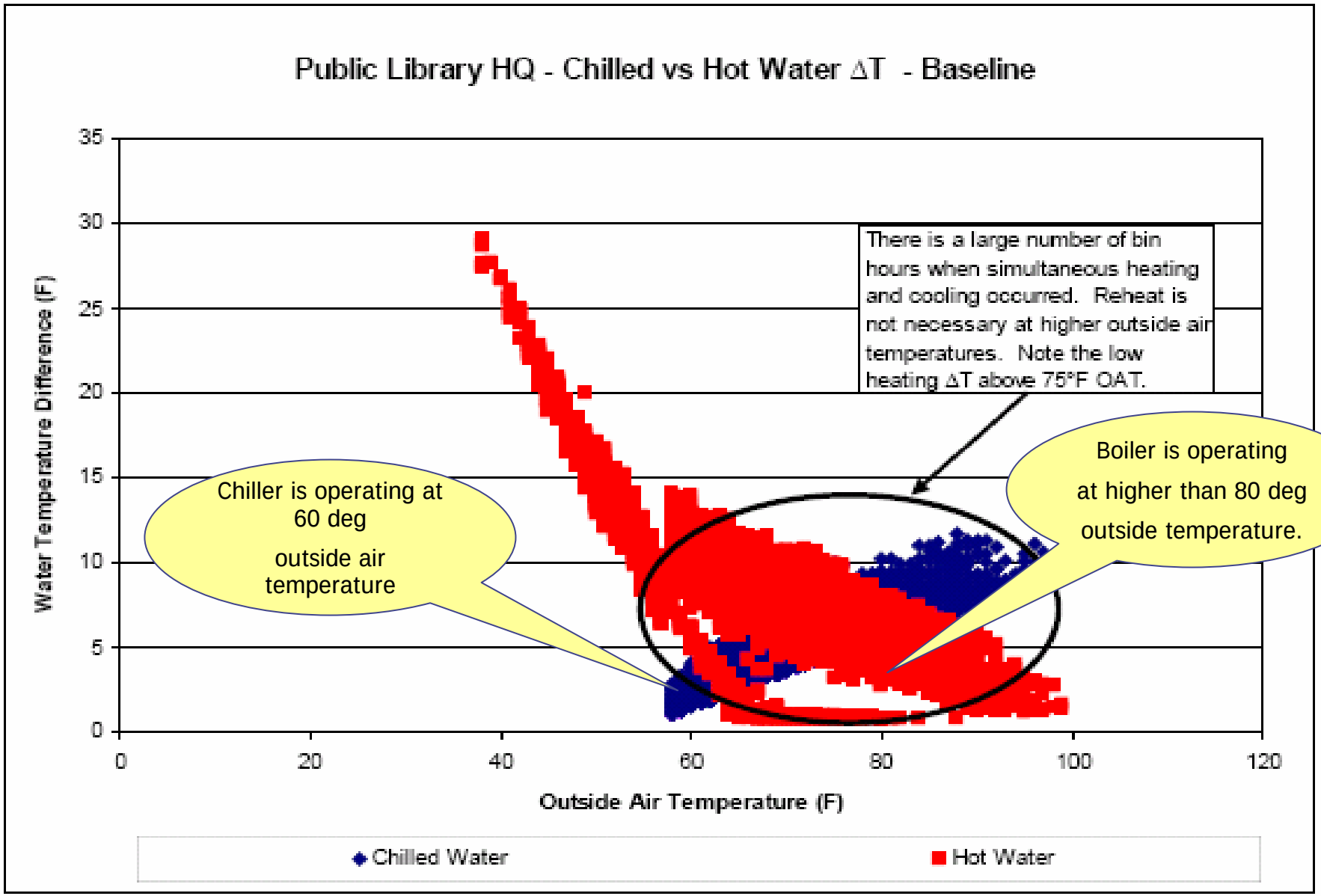
HVAC RCx Measures

- Improved Chiller and Pump Sequencing
- Improved Boiler Combustion Efficiency
- Installed Boiler Hot Water Temp Reset Controls
- Performed Diagnostic Air and Hydronic Testing
- Optimized Economizer Controls
- Installed Discharge Air Temp Reset Controls
- Improved VAV Static Pressure Controls
- Selective air balancing and terminal box repairs
- Tested and calibrated all existing controls
- Control programming upgrades

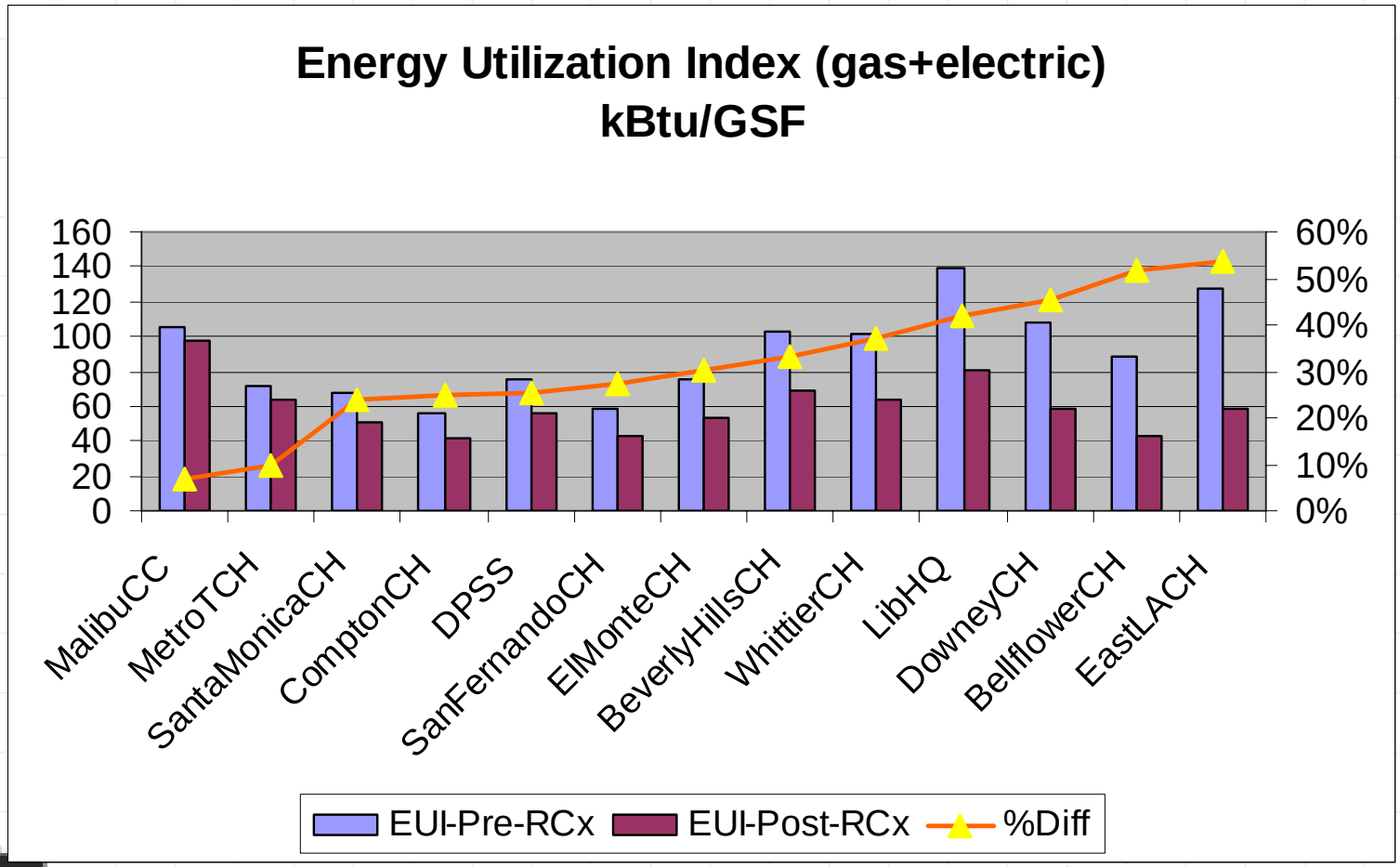
Bellflower Courthouse
eQUEST Model Savings



Public Library Headquarters
Simultaneous Heat / Cool



Energy (electric + gas) Utilization Pre- & Post-RCx



RCx Utility Bill Saving
First Year

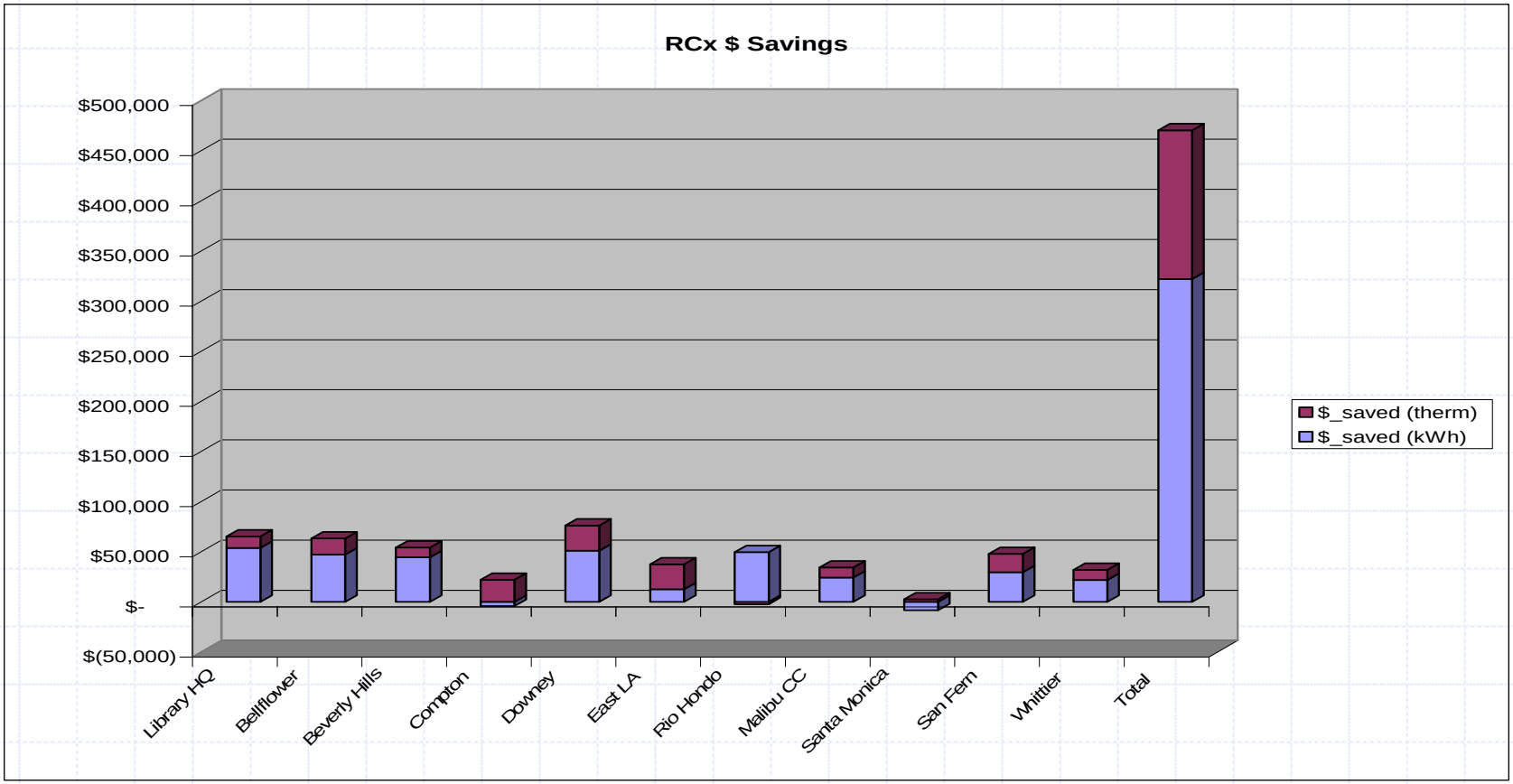


Figure 21: Post-RCx operational savings ($).

RCx kWh Savings Against Baseline

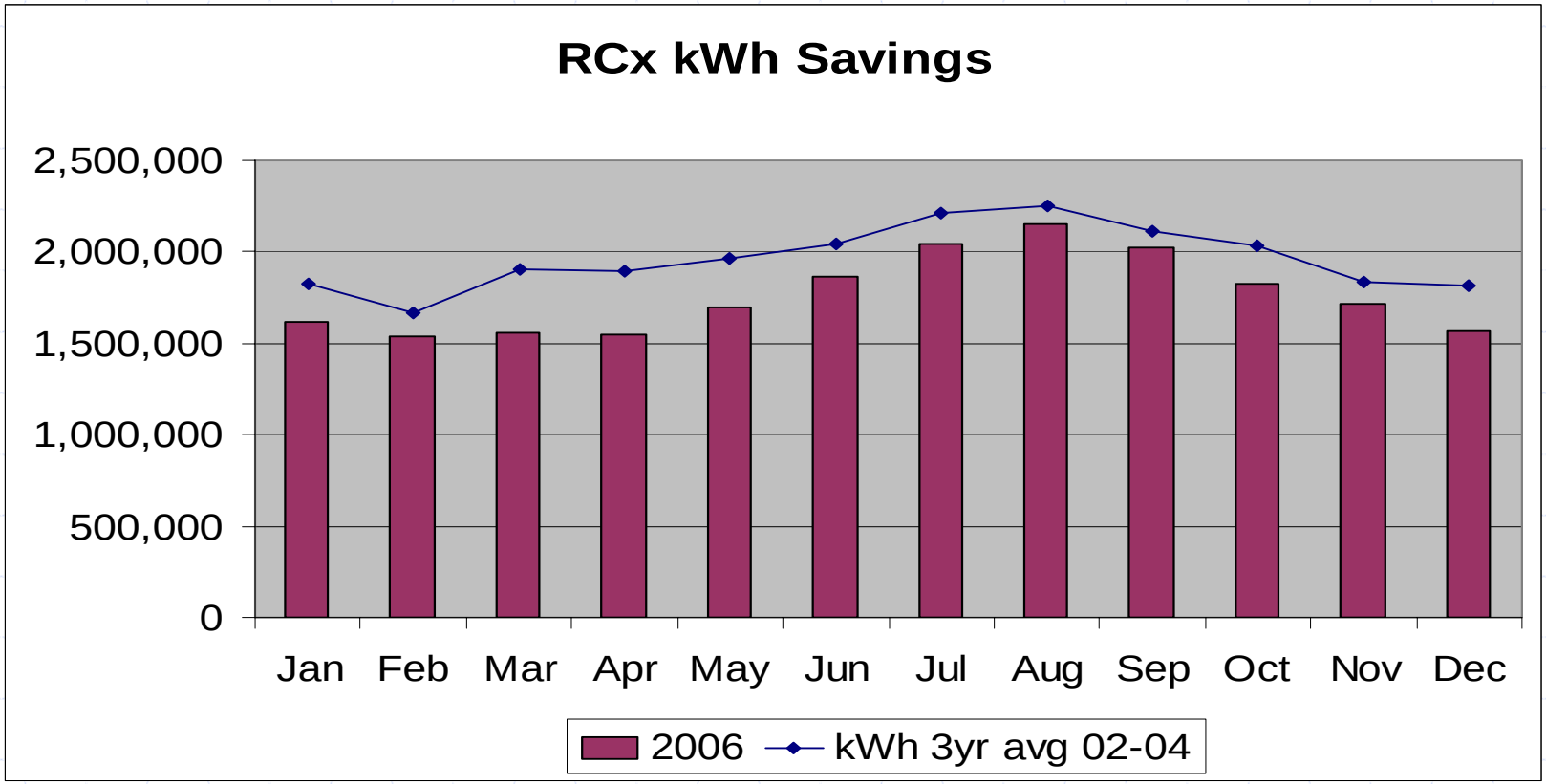


Figure 22: Post-RCx electric energy (kWh) savings.

RCx Therm Savings Against Baseline

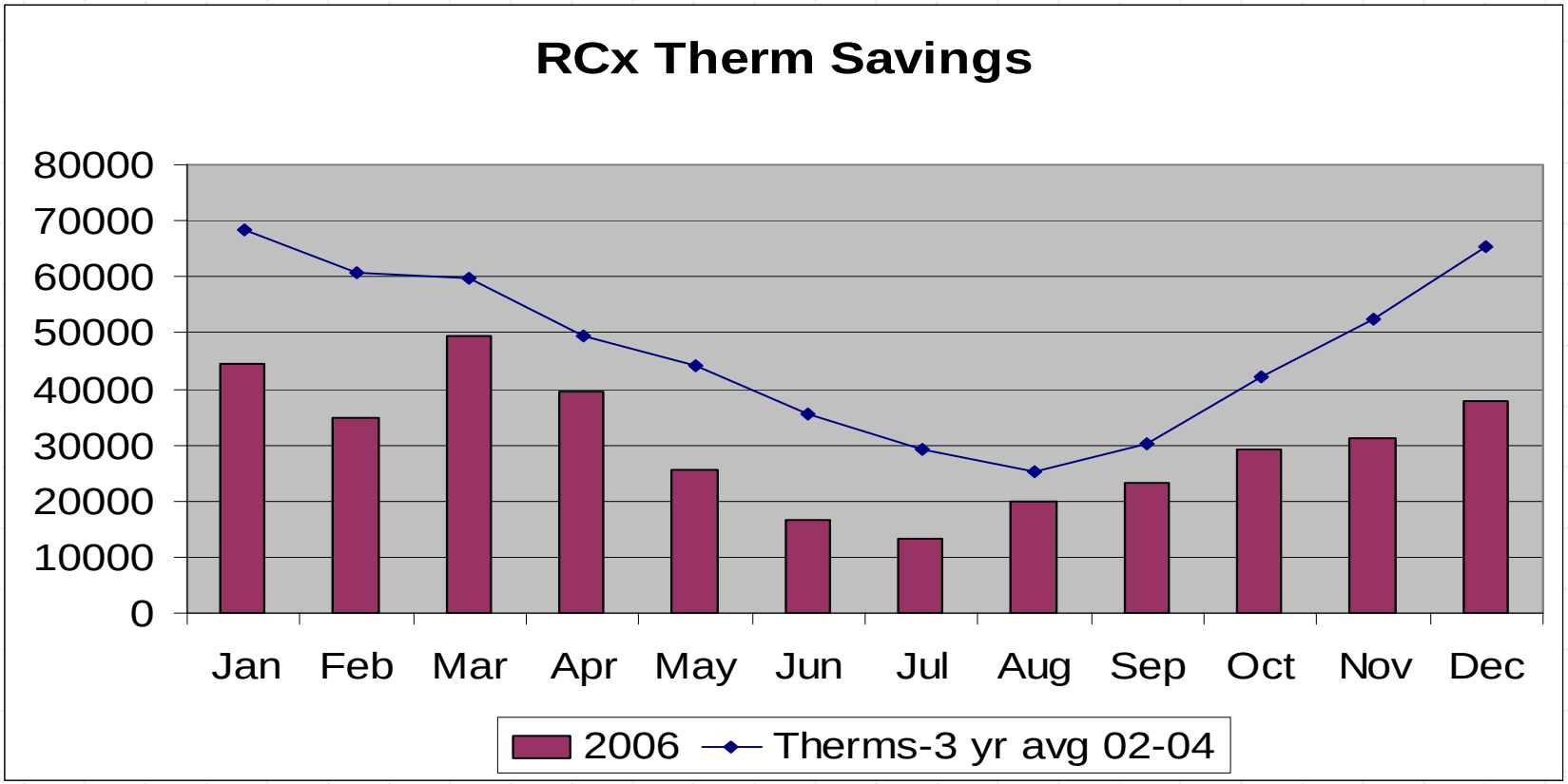


Figure 23: Post-RCx gas energy (therms) savings.

RCx+EEMIS+M&O=Optimized HVAC

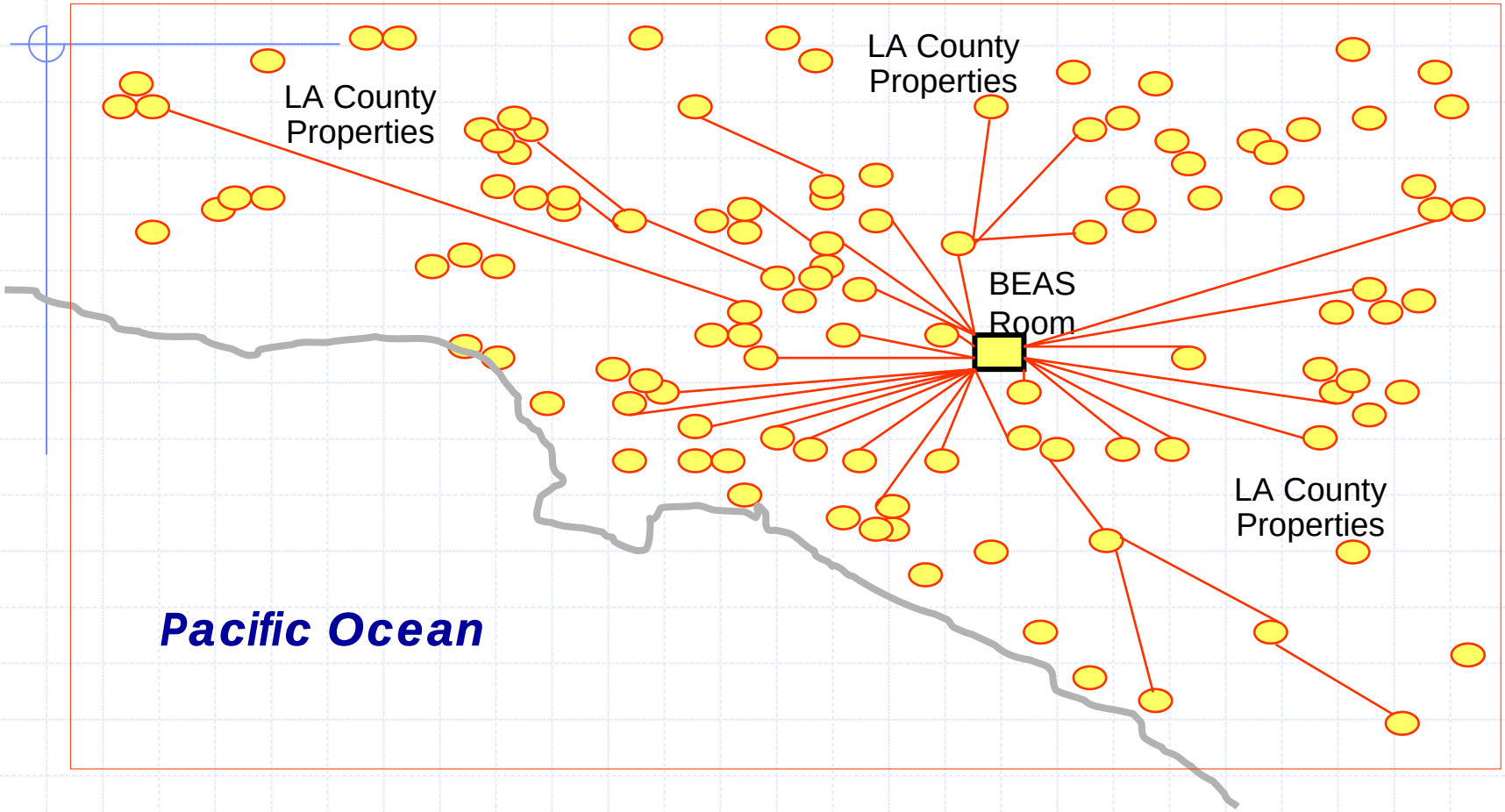
Optimized HVAC Building Operations

HVAC RCx Project
- Funding
- Contract w/RCx Provider
- Optimize buildings

Maintenance & Operations
- Continue optimized operations

EEMIS
- Automation
- System-level Benchmarks
- Monitoring
- M&O Support

Enterprise Energy Management Information System - EEMIS



- Los Angeles County covers more than 4000 square miles

What is EEMIS?

- A network of discrete facility systems, hardware and data streams that are accessible through a centralized data-base using presentation & analytical tools for operational and management functions
- Real Time - Ethernet LAN / WAN based communications
- EEMIS is comprised of four main Sub-Systems
  - Teletrol's BAS for the County's HVAC operations in 65 facilities
  - Cutler Hammer's PowerNet Metering Systems in 125 facilities
  - Square D's PowerLink Lighting Panels. 165 Panels each with it's own controller, installed in 12 Facilities
  - Itron's Energy Suite Software Application

L A County EEMIS Network

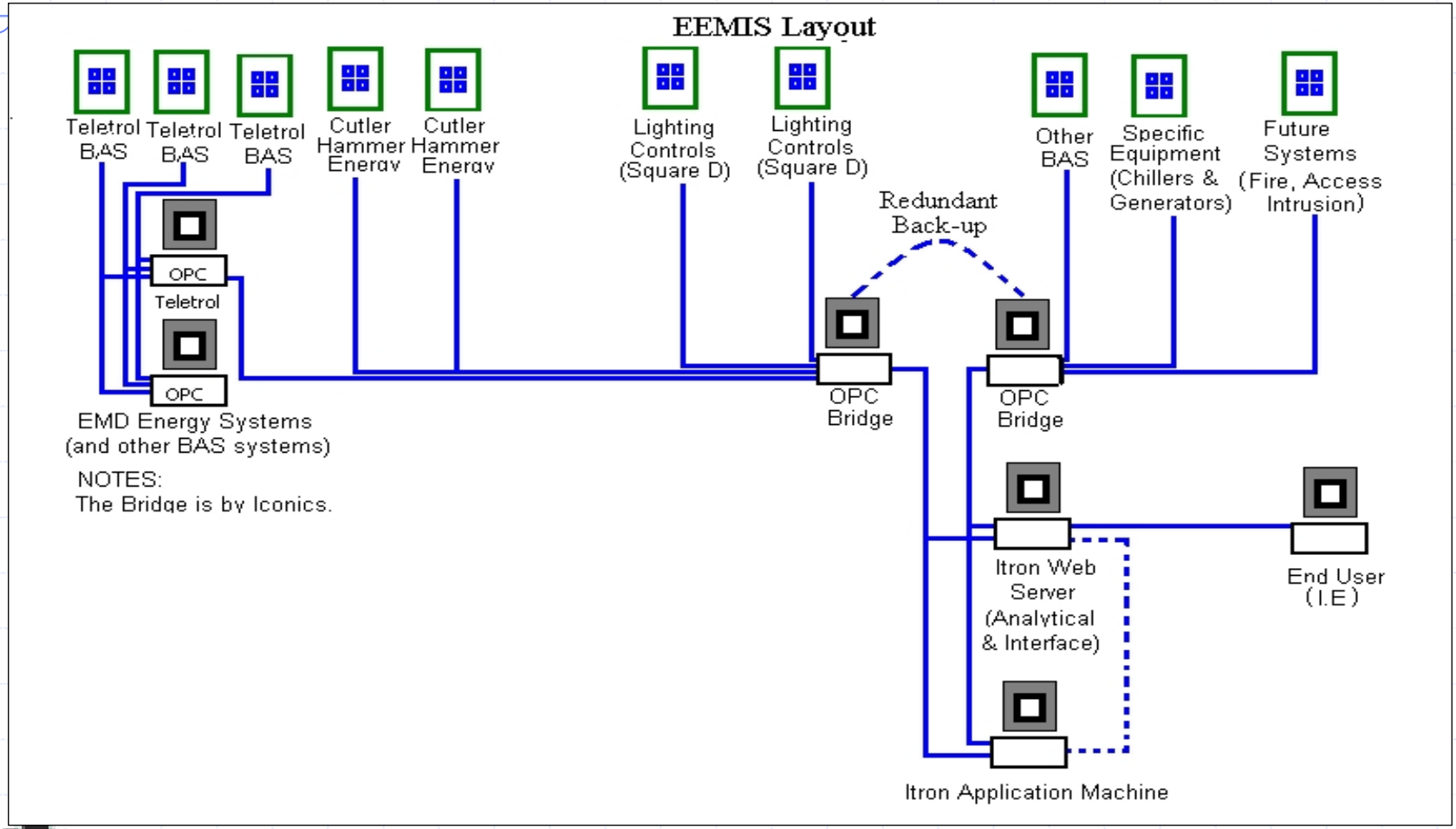


Figure 4: County of Los Angeles Enterprise Energy Management Information System (EEMIS) configuration.

Enhanced Monitoring
3-Prong Approach

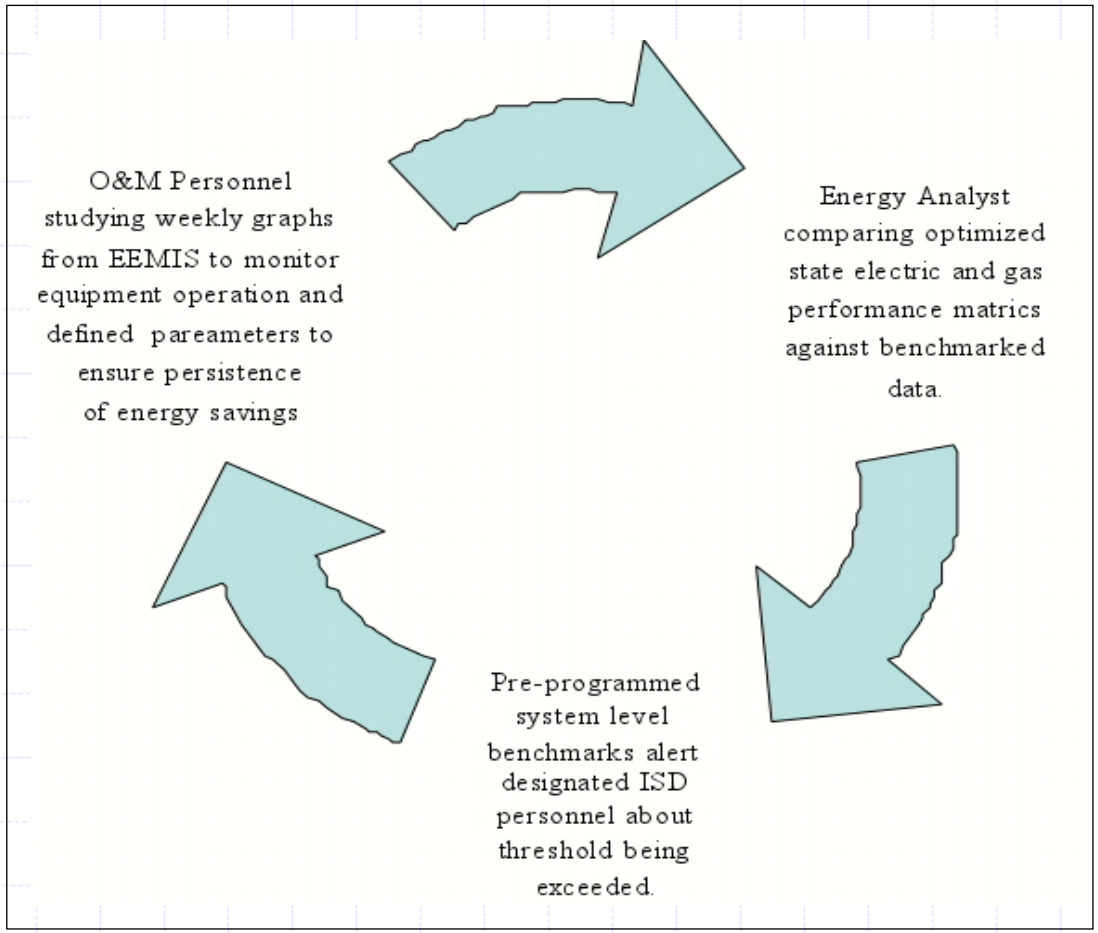
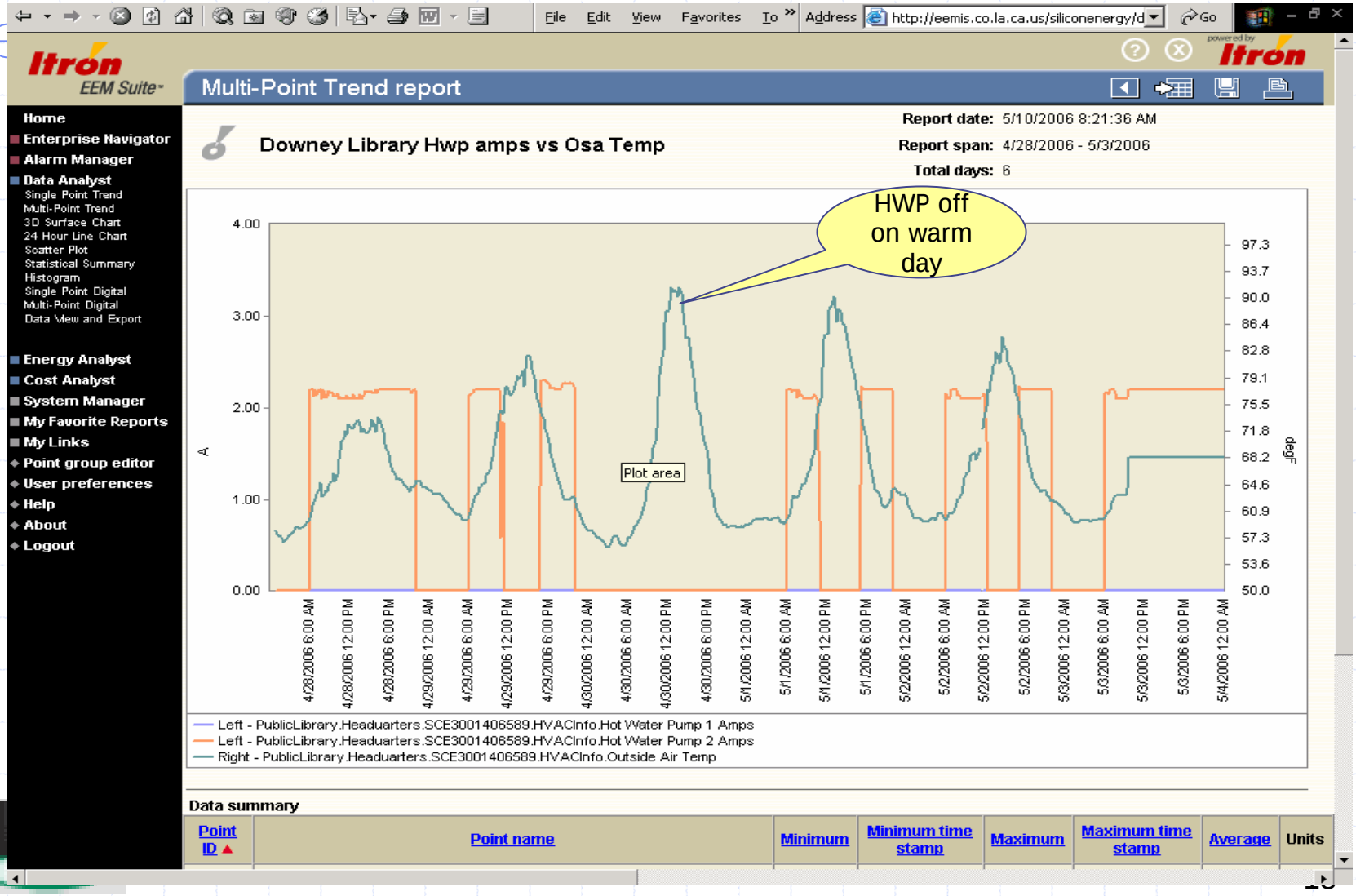


Figure 3: Three-prong approach for persistence of RCx savings.

Hot Water Pump Operation



Cold Deck Temperature Reset

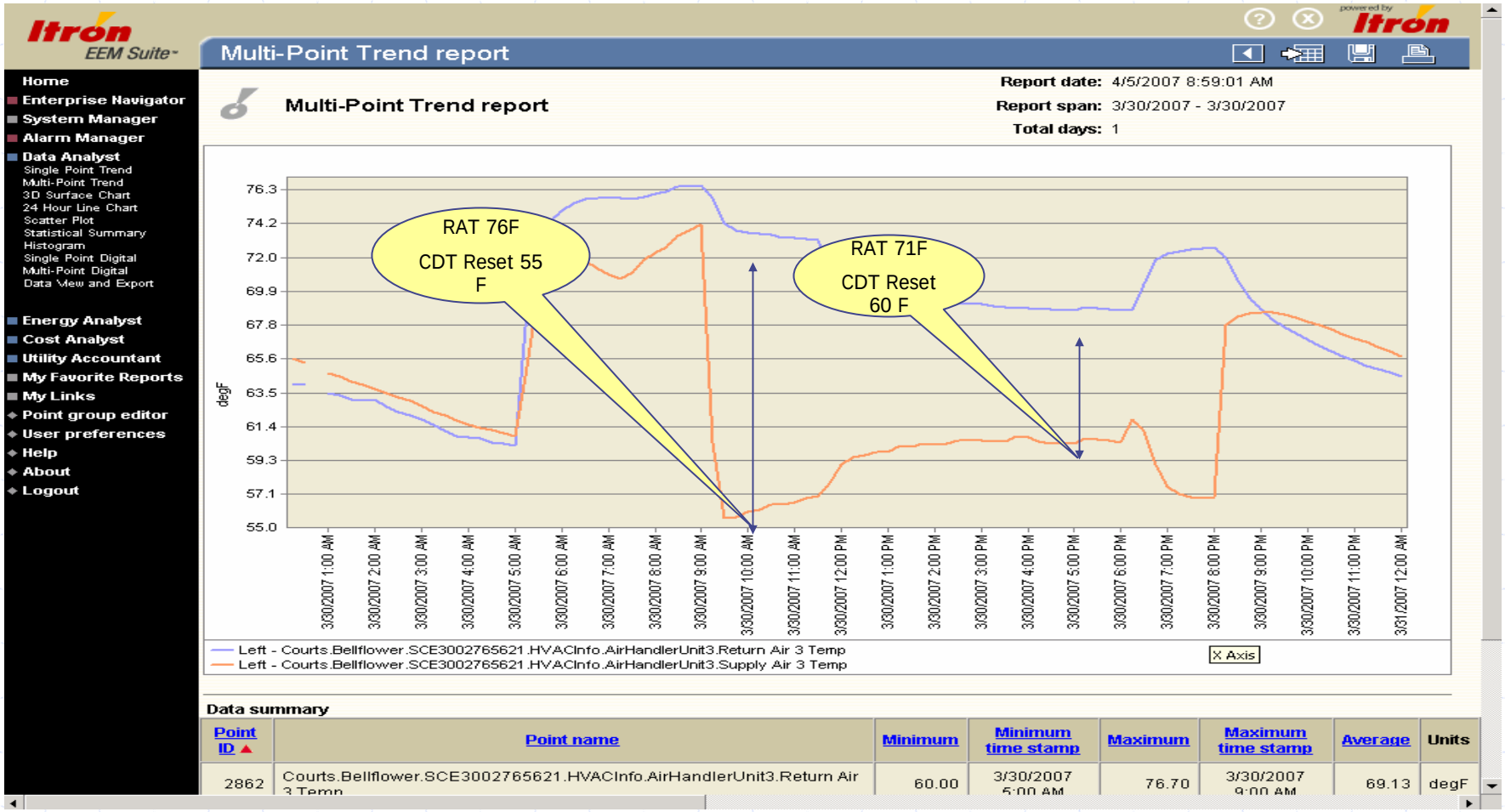


Figure 8: Supply air vs. return air temperature.

eQUEST Energy Modeling

- eQUEST® is a building energy use analysis tool
- eQUEST = enhanced DOE-2 + Wizards + Graphics
- Free download from http://www.energydesignresources.com
- System-level benchmarks are based on hourly output
  - Ton vs. OSAT
  - kW vs. Ton
  - Run-hours against timescale
  - kWh against timescale
  - Therms against timescale

eQUEST Output – Bin Data
OSAT Vs. Chiller kW

Table 4-2. Data Set – Average Chiller Demand vs. OAT (Including Confidence Intervals)

OAT	Average kW	Number of Samples	Std Dev	Avg kW+ StdDev	Avg kW - StdDev	Avg kW + 2*StdDev	Avg kW - 2*StdDev
58	36.5	82	12.4	48.9	24.1	61.3	11.7
59	36.5	108	11.3	47.9	25.2	59.2	13.9
60	43.1	129	17.1	60.2	25.9	77.4	8.8
61	46.8	151	19.0	65.8	27.8	84.7	8.8
62	50.3	151	19.1	69.3	31.2	88.4	12.2
63	50.3	140	18.9	69.3	31.4	88.2	12.5
64	54.9	143	18.1	73.1	36.8	91.2	18.7
65	57.8	122	17.7	75.6	40.1	93.3	22.4
66	60.2	120	19.1	79.4	41.1	98.5	21.9
67	60.5	100	16.9	77.4	43.6	94.4	26.6
68	69.1	93	18.7	87.8	50.3	106.5	31.6
69	65.2	86	15.7	80.8	49.5	96.5	33.9
70	71.1	80	17.1	88.2	54.0	105.3	36.9
71	72.7	61	17.1	89.8	55.5	106.9	38.4
72	68.4	73	15.0	83.5	53.4	98.5	38.4
73	70.9	78	13.8	84.7	57.0	98.6	43.2
74	75.4	54	13.9	89.3	61.5	103.3	47.6
75	78.0	70	14.7	92.7	63.3	107.4	48.6
76	80.7	52	13.6	94.3	67.1	107.9	53.5
77	81.0	59	11.9	93.0	69.1	104.9	57.2
78	82.7	70	12.8	95.5	70.0	108.3	57.2
79	86.6	68	13.9	100.5	72.7	114.4	58.8
80	88.2	62	12.6	100.8	75.6	113.5	63.0
81	88.7	54	13.7	102.4	75.1	116.0	61.4
82	94.1	47	9.0	103.1	85.1	112.1	76.1
83	93.8	43	11.7	105.5	82.2	117.1	70.5
84	93.6	37	13.0	106.6	80.7	119.5	67.7
85	94.5	42	10.8	105.2	83.7	116.0	72.9
86	98.7	32	10.4	109.1	88.4	119.4	78.0
87	100.2	36	11.8	112.0	88.3	123.8	76.5
88	101.1	34	13.2	114.3	87.9	127.4	74.7
89	106.4	27	8.6	115.1	97.8	123.7	89.1
90	102.8	22	9.9	112.7	92.9	122.7	82.9
91	101.7	20	10.4	112.2	91.3	122.6	80.9
92	104.5	10	10.4	114.8	94.1	125.2	83.8
93	104.3	11	8.7	113.0	95.6	121.7	86.9
94	101.4	6	7.2	108.6	94.3	115.8	87.1
95	103.9	8	7.6	111.5	96.4	119.1	88.8
96	107.2	7	6.3	113.4	100.9	119.7	94.7
97	106.6	5	6.4	113.0	100.3	119.4	93.9
98	112.6	1	0.0	112.6	112.6	112.6	112.6
99	104.0	2	0.5	104.5	103.6	105.0	103.1

System Level Benchmark
Chiller kW Vs. OAT

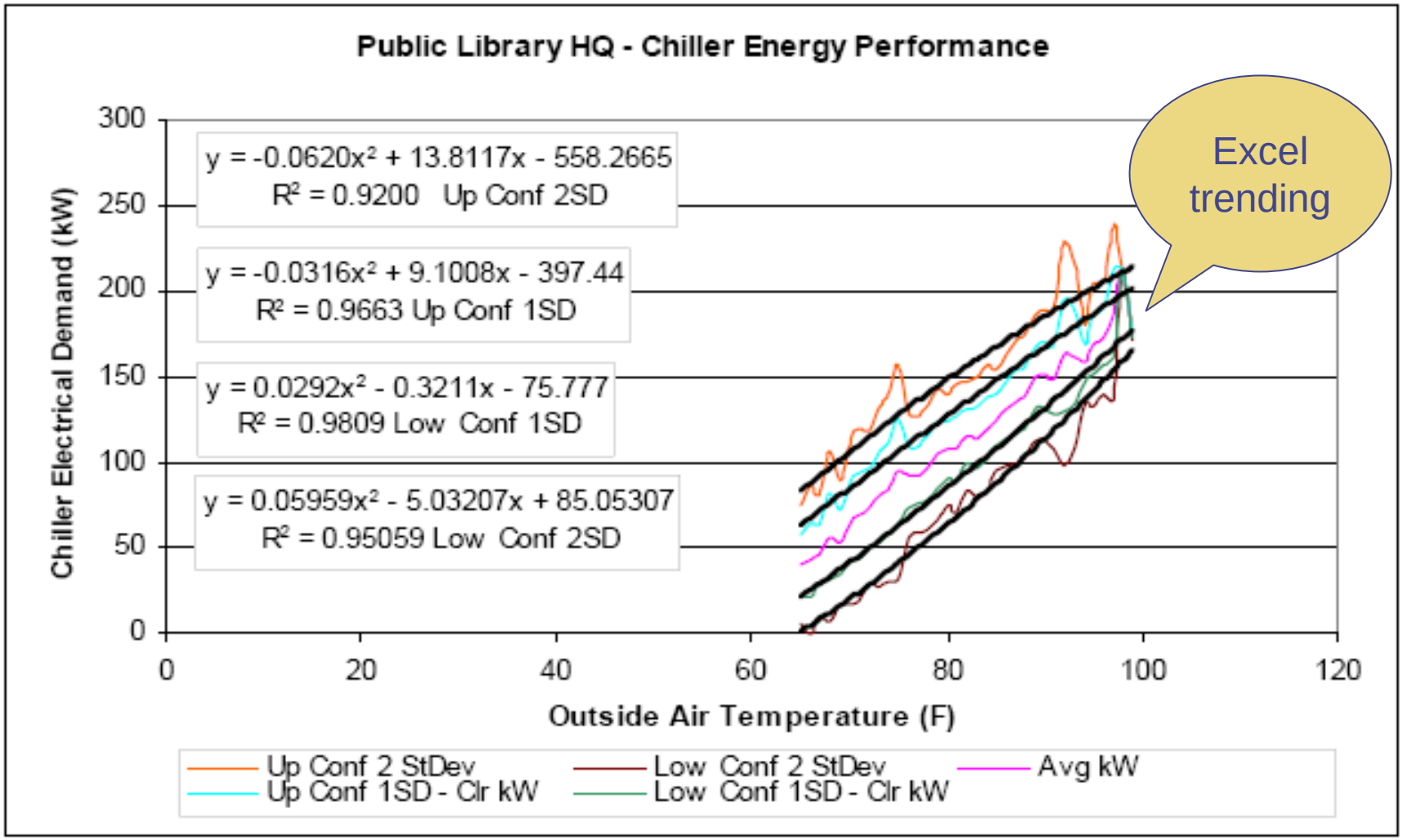
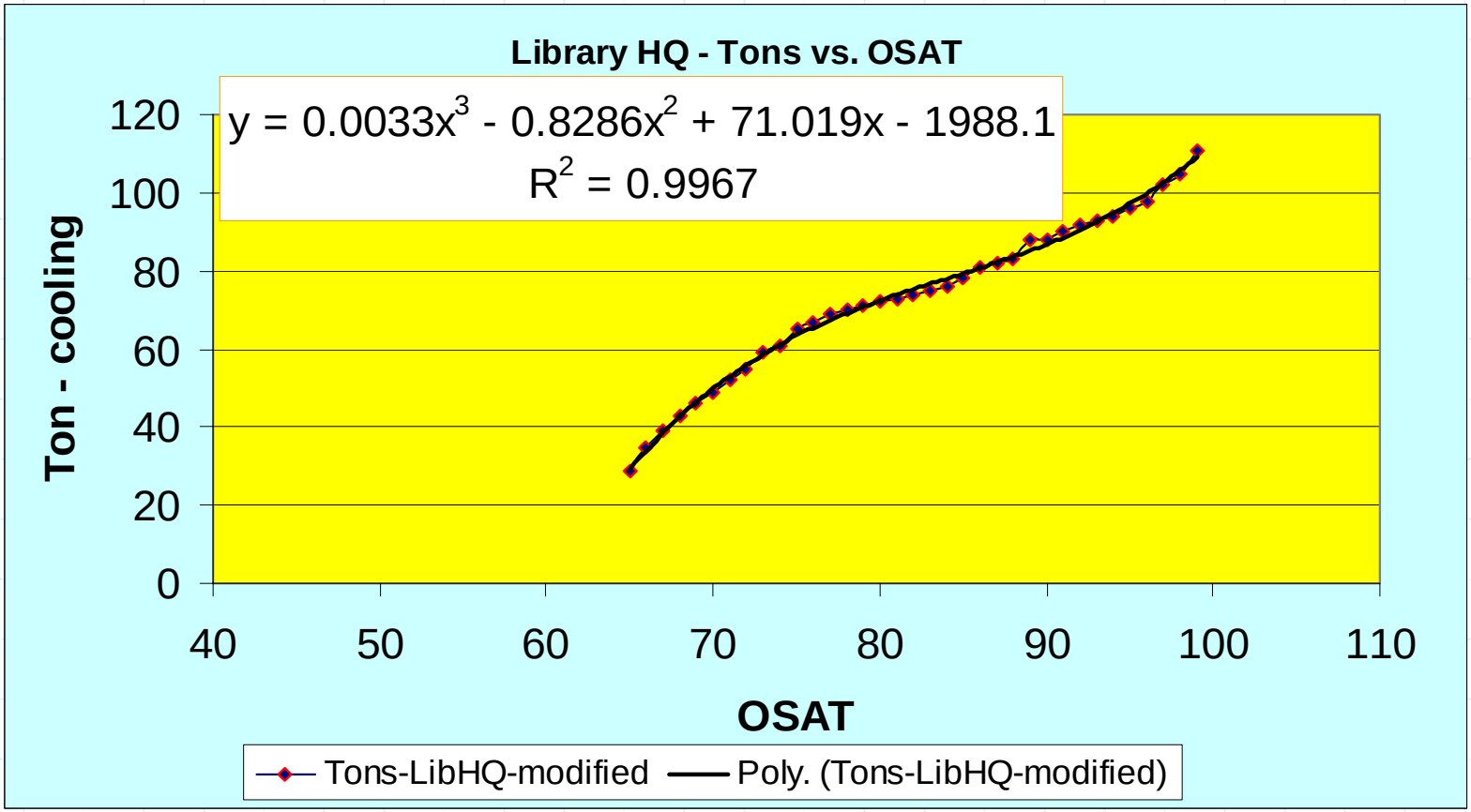


Figure 4-2. Chiller Energy Performance – Representation with Equations

Weather Corrected eQUEST Equation



System-level Benchmarking
EEMIS UCE+ Example

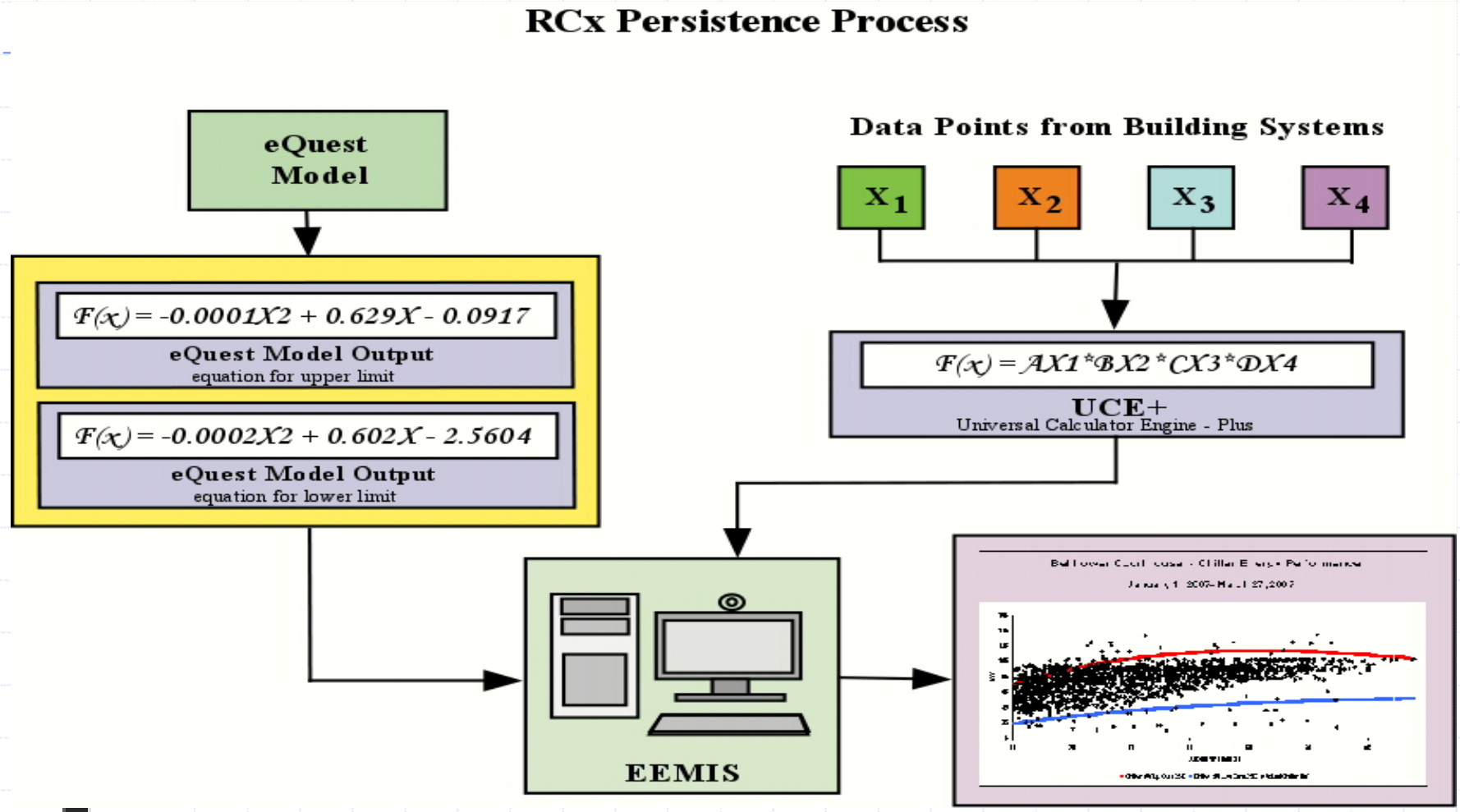
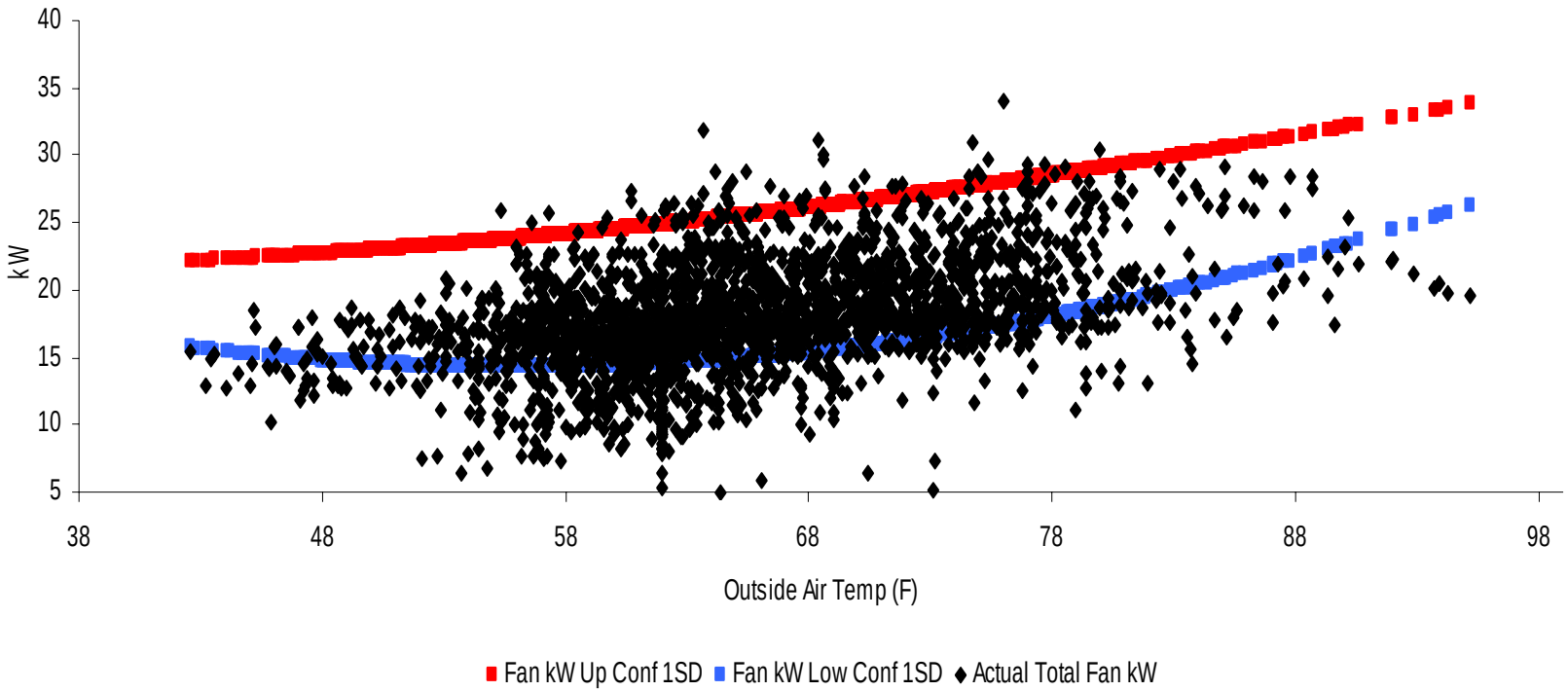


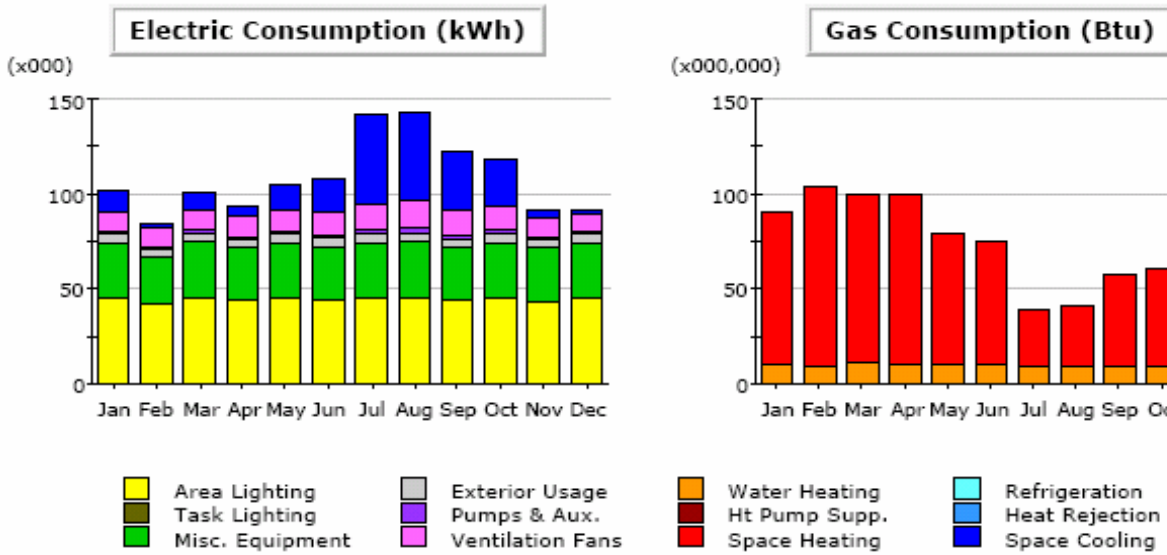
Figure 20: RCx persistence process utilizing Universal Calculation Engine Plus (UCE+).

Public Library Headquarters
VFD Fan Performance



Optimized eQUEST Output

Project/Run: Downey Public Library - 7 Run Date/Time: 02/24/06 @ 14:01



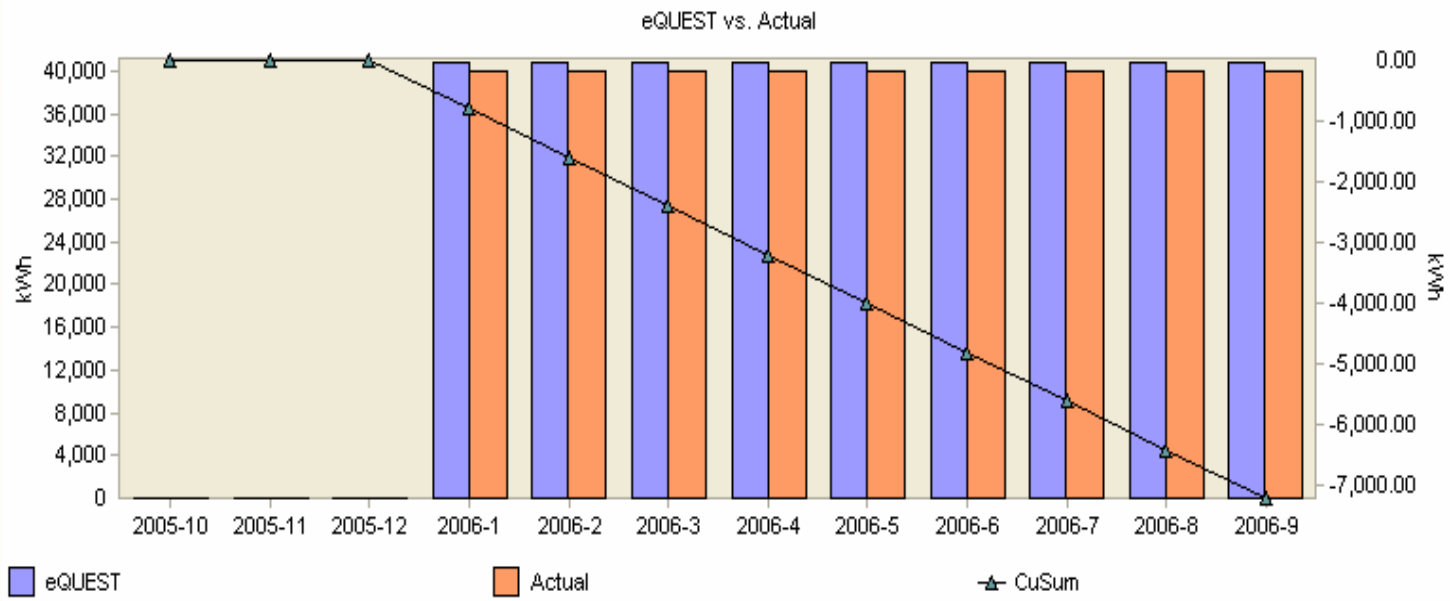
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	10.5	2.0	9.0	5.1	12.3	16.9	47.6	46.9	30.4	25.5	3.7	2.0	211.8
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	11.0	9.8	11.5	11.1	12.0	12.9	13.8	15.0	13.2	12.9	10.7	10.3	144.3
Pumps & Aux.	1.4	0.8	1.4	1.1	1.5	1.8	2.3	2.4	2.1	1.9	0.9	0.9	18.4
Ext. Usage	4.5	4.0	4.5	4.3	4.5	4.3	4.5	4.5	4.3	4.5	4.3	4.5	52.6
Misc. Equip.	28.8	26.1	29.1	28.1	28.9	28.2	28.8	29.1	28.1	28.8	27.9	28.9	340.9
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	45.3	41.0	45.5	43.9	45.4	44.0	45.3	45.5	43.9	45.3	43.9	45.4	534.3
Total	101.5	83.7	100.9	93.6	104.5	108.1	142.2	143.5	122.0	118.9	91.5	91.9	1,302.3

eQUEST vs Actual - kWh

Single-level Bill Scenario Variance

Facility: NW Regional HQ **Report date:**
City, Region: Seattle, WA **Start period:**
Provider: All providers **End period:**



eQUEST vs. Actual

Facility	Commodity	Unit	Scenario	2005-10 (Oct-05)	2005-11 (Nov-05)	2005-12 (Dec-05)	2006-1 (Jan-06)	2006-2 (Feb-06)	2006-3 (Mar-06)	2006-4 (Apr-06)	2006-5 (May-06)	2006-6 (Jun-06)	2006-7 (Jul-06)	
NW Regional HQ	Electricity	kWh	eQUEST				40,800.00	40,800.00	40,800.00	40,800.00	40,800.00	40,800.00	40,800.00	40
			Actual				40,000.00	40,000.00	40,000.00	40,000.00	40,000.00	40,000.00	40,000.00	40
			Variance				-800.00	-800.00	-800.00	-800.00	-800.00	-800.00	-800.00	
			CuSum				-800.00	-1,600.00	-2,400.00	-3,200.00	-4,000.00	-4,800.00	-5,600.00	-6

Note: Data is prorated to fiscal periods

Recap: HVAC Retro-commissioning and EEMIS Monitoring

- HVAC Retro-commissioning
  - Investigate and resolve operational deficiencies
  - Install and test Energy Efficiency Measures
  - Develop system-level benchmarks

- 3-Prong approach to sustain RCx savings
  - Facility operation monitoring
  - Utility bill analysis with whole building benchmarks
  - System-level benchmarks to detect deviations

Partnership Credits

- Southern California Edison
  - Michael Lo, Program Manager
- Southern California Gas Co.
  - Paulo Morais, Project Manager
- County of Los Angeles – Internal Services Dept.
  - Howard Choy, Division Manager, ISD, Los Angeles County
  - Nora Hernandez, Section Manager, ISD, Los Angeles County

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